

Appendix A

Emission Inventory Calculations

Buys & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS Emission Inventory
Date: 4/21/03

1. Well Pad and Road Construction Emissions (Dozer and Backhoe)

Assumptions:

Well Pad and Road Area	11.27 acres (Desolation Flats EIS Chapter 2)
Hours of Construction	5 days per well pad (Desolation Flats EIS Chapter 2) 8 hours/day 40 hours per well pad
Watering Control Efficiency	50 percent (Recommended by Wy DEQ)
Soil Moisture Content	7.9 percent (AP-42 Table 11.9-3, 10/98)
Soil Silt Content	6.9 percent (AP-42 Table 11.9-3, 10/98)
PM10 Multiplier	0.75 * PM15 (AP-42 Table 11.9-1, 10/98)
PM2.5 Multiplier	0.105 * TSP (AP-42 Table 11.9-1, 10/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content \%})^{1.2} * (\text{soil moisture content \%})^{-1.3} * \text{Control Efficiency}$

Emissions (PM15 lbs/hr) = $1.0 * (\text{soil silt content \%})^{1.5} * (\text{soil moisture content \%})^{-1.4} * \text{Control Efficiency}$

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM15/hour/piece of equipment

	Dozer and Backhoe Emissions ^a		
	lbs/hr	tons/well	tons/yr ^b
TSP	3.94	0.0788	3.55
PM15	1.00	0.0201	0.90
PM10	0.75	0.0151	0.68
PM2.5	0.41	0.0083	0.37

a Assumes one dozer and one backhoe. Backhoe emissions are conservatively estimated as equivalent to Dozer emissions.

b Assumes a maximum construction rate of 45 wells/year

**Buys & Associates, Inc.
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2. Well Pad and Road Construction Emissions (Grader)

Assumptions:

Road Length	1.50 miles (Desolation Flats EIS Chapter 2)
Hours of Construction	5 days per well pad (Desolation Flats EIS Chapter 2) 8 hours/day 40 hours per well pad
Watering Control Efficiency	50 percent (Recommended by Wy DEQ)
Average Grader Speed	10 mph (Typical value)
Distance Graded	6 miles (2 round trips on road)
PM10 Multiplier	0.6 * PM15 (AP-42 Table 11.9-1, 10/98)
PM2.5 Multiplier	0.031 * TSP (AP-42 Table 11.9-1, 10/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

$$\text{Emissions (TSP lbs)} = 0.040 * (\text{Mean Vehicle Speed})^{2.5} * \text{Distance Graded} * \text{Control Efficiency}$$

$$\text{Emissions (PM15 lbs)} = 0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$$

$$\text{Emissions} = 37.95 \text{ lbs TSP/well}$$

$$\text{Emissions} = 15.30 \text{ lbs PM15/well}$$

	Grader Construction Emissions			
	lbs/well	lbs/hr	tons/well	tons/yr ^a
TSP	37.95	0.95	0.0190	0.85
PM15	15.30	0.38	0.0077	0.34
PM10	9.18	0.23	0.0046	0.21
PM2.5	1.18	0.03	0.0006	0.03

a Assumes a maximum construction rate of 45 wells/year

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3. Construction Traffic Fugitive Dust Emissions

Assumptions:

Average Round Trip Distance	15 miles (Estimated from Project Area and existing road system)
Hours of Construction	40 hours per site (Desolation Flats EIS Chapter 2)
Watering Control Efficiency	50 percent (Wy DEQ Recommendation)
Road Silt Content	5.1 percent (AP-42 Table 13.2.2-1, 9/98)
Road Moisture	0.2 percent (Default Value, AP-42 Section 13.2.2, 9/98)

Equation: From AP-42 13.2.2, Unpaved Roads, 9/98

$$E \text{ Size Spec. Factor (lb/VMT)} = \frac{k * (s/12)^a * (W/3)^b * \text{Control Efficiency}}{(M/0.2)^c}$$

Where k, a, b, and c are empirical constants listed below and

E = size-specific emission factor (lbs/VMT)
 s = surface material silt content (%)
 W = mean vehicle weight (tons)
 M = surface material moisture content (%)

Empirical Constants			
Constant	PM2.5	PM10	PM30/TSP
k	0.38	2.6	10.0
a	0.8	0.8	0.8
b	0.4	0.4	0.5
c	0.3	0.3	0.4

Buys & Associates, Inc. Environmental Consultants					Project: Desolation Flats EIS Emission Inventory Date: 4/21/03							
3. Construction Traffic Fugitive Dust Emissions continued												
Vehicle Type	Ave. Weight (lbs)	Round Trips per Well	Hours Per Activity	Controlled Emission Factors (lbs/VMT)			TSP Emissions		PM10 Emissions		PM2.5 Emissions	
				TSP	PM10	PM2.5	Max. lb/hr	Tons/well	Max. lb/hr	Tons/well	Max. lb/hr	Tons/well
Construction Activities												
Semi: Hvy Equip Hauler	74,000	3	40	8.86	1.79	0.26	9.96	0.20	2.01	0.04	0.29	0.01
Haul Truck:Gravel	48,000	2	40	7.13	1.51	0.22	5.35	0.11	1.13	0.02	0.17	0.00
Pickup Truck: Crew	7,000	5	40	2.72	0.70	0.10	5.11	0.10	1.31	0.03	0.19	0.00
Construction Total							20.42	0.41	4.45	0.09	0.65	0.01
Drilling Activities												
Semi: Rig Transport	60,000	22	1320	7.97	1.65	0.24	1.99	1.32	0.41	0.27	0.06	0.04
Haul Truck:Fuel	48,000	55	1320	7.13	1.51	0.22	4.46	2.94	0.94	0.62	0.14	0.09
Haul Truck: Mud	48,000	8	1320	7.13	1.51	0.22	0.65	0.43	0.14	0.09	0.02	0.01
Logging Trucks	48,000	4	1320	7.13	1.51	0.22	0.32	0.21	0.07	0.05	0.01	0.01
Haul Truck: Gravel	48,000	2	1320	7.13	1.51	0.22	0.16	0.11	0.03	0.02	0.01	0.00
Haul Truck: Water	20,000	20	1320	4.60	1.06	0.16	1.05	0.69	0.24	0.16	0.04	0.02
Pickup Truck: Rig Crew	7,000	110	1320	2.72	0.70	0.10	3.40	2.25	0.87	0.58	0.13	0.08
Pickup Truck: Mechanic	8,000	8	1320	2.91	0.74	0.11	0.26	0.17	0.07	0.04	0.01	0.01
Pickup Truck: Supervisor	7,000	8	1320	2.72	0.70	0.10	0.25	0.16	0.06	0.04	0.01	0.01
Pickup Truck: Mud Logger	8,000	110	1320	2.91	0.74	0.11	3.64	2.40	0.92	0.61	0.13	0.09
Pickup: Mud Engineer	7,000	55	1320	2.72	0.70	0.10	1.70	1.12	0.44	0.29	0.06	0.04
Pickup: Bit/Tool Delivery	8,000	16	1320	2.91	0.74	0.11	0.53	0.35	0.13	0.09	0.02	0.01
Total Drilling							18.42	12.16	4.32	2.85	0.63	0.42
Completion Activities												
Semi: Casing	74,000	6	160	8.86	1.79	0.26	4.98	0.40	1.01	0.08	0.15	0.01
Cement Haul Trucks	74,000	6	160	8.86	1.79	0.26	4.98	0.40	1.01	0.08	0.15	0.01
Cement Pump Truck	48,000	2	160	7.13	1.51	0.22	1.34	0.11	0.28	0.02	0.04	0.00
Completion Rig	74,000	1	160	8.86	1.79	0.26	0.83	0.07	0.17	0.01	0.02	0.00
Completion Rig Equip Truck	48,000	4	160	7.13	1.51	0.22	2.67	0.21	0.56	0.05	0.08	0.01
Frac Trucks	80,000	12	160	9.21	1.85	0.27	10.36	0.83	2.08	0.17	0.30	0.02
Haul: Frac Tanks	48,000	6	160	7.13	1.51	0.22	4.01	0.32	0.85	0.07	0.12	0.01
Haul: Frac Sand	44,000	30	160	6.83	1.45	0.21	19.21	1.54	4.09	0.33	0.60	0.05
Haul: Frac Chemicals	44,000	4	160	6.83	1.45	0.21	2.56	0.20	0.55	0.04	0.08	0.01
Logging/Perf. Truck	48,000	8	160	7.13	1.51	0.22	5.35	0.43	1.13	0.09	0.17	0.01
Pickup: Comp Foreman	7,000	40	160	2.72	0.70	0.10	10.21	0.82	2.61	0.21	0.38	0.03
Pickup: Casing Crews	7,000	4	160	2.72	0.70	0.10	1.02	0.08	0.26	0.02	0.04	0.00
Pickup: Cement Crew	8,000	4	160	2.91	0.74	0.11	1.09	0.09	0.28	0.02	0.04	0.00
Pickup: Completion Rig Crew	7,000	20	160	2.72	0.70	0.10	5.11	0.41	1.31	0.10	0.19	0.02
Pickup: Frac Crew	7,000	4	160	2.72	0.70	0.10	1.02	0.08	0.26	0.02	0.04	0.00
Pickup: Logging/Perf. Crew	7,000	8	160	2.72	0.70	0.10	2.04	0.16	0.52	0.04	0.08	0.01
Welders	8,000	4	160	2.91	0.74	0.11	1.09	0.09	0.28	0.02	0.04	0.00
Roustabout Crews	8,000	4	160	2.91	0.74	0.11	1.09	0.09	0.28	0.02	0.04	0.00
Supply Trucks	8,000	16	160	2.91	0.74	0.11	4.37	0.35	1.10	0.09	0.16	0.01
Total Completion							83.34	6.67	18.62	1.49	2.72	0.22
Field Development												
Gathering Sys. Const. Crew	8,000	4	32	2.91	0.74	0.11	5.46	0.09	1.38	0.02	0.20	0.00
Haul Truck: Trencher	48,000	1	32	7.13	1.51	0.22	3.34	0.05	0.71	0.01	0.10	0.00
Haul Truck: Pipe	48,000	6	32	7.13	1.51	0.22	20.06	0.32	4.24	0.07	0.62	0.01
Surveyor	7,000	1	32	2.72	0.70	0.10	1.28	0.02	0.33	0.01	0.05	0.00
Welder	8,000	4	32	2.91	0.74	0.11	5.46	0.09	1.38	0.02	0.20	0.00
Reclamation Crew	8,000	1	32	2.91	0.74	0.11	1.36	0.02	0.34	0.01	0.05	0.00
Total Field Development							36.96	0.59	8.37	0.13	1.22	0.02
Total Well Traffic Emissions (per/well)							159.14	19.82	35.77	4.57	5.23	0.67
Annual Traffic Emissions (Tons/year for 45 wells)								892.10		205.52		30.04

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4. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity U_t^* : 1.02 m/s for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
1.33 m/s for roads (AP-42 Table 13.2.5-2 Roadbed Material)

$$\text{Fastest Mile } U_{10}^+ = \text{Wind Speed (U)}^* * 1.2$$

Exposed Area: 4.0 acres per well pad (Desolation Flats EIS Chapter 2)
7.27 acres per well road (Desolation Flats EIS Chapter 2)
16,187 square meters per well pad (4.0 acres)
2,881,357 square meters project non-road disturbance following reclamation (712 acres)
10,614,888 square meters project road disturbance (2623 acres)

Exposed Surface Type: Flat

Meteorological Data: 1995 - Baggs, Wyoming

Equations

$$\text{Friction Velocity } U^* = 0.53 U_{10}^+$$

$$\text{Erosion Potential } P (\text{g/m}^2/\text{period}) = 58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*) \text{ for } U^* > U_t^*, \quad P = 0 \text{ for } U^* < U_t^*$$

Emissions (lb/period) = (sum of the P values) * (k) / (453.6 g/lb), where k is the particle size multiplier

Particle Size Multiplier (k)		
30 um	<10 um	<2.5 um
1.0	0.5	0.2

1995 Baggs, Wy Met Data

Count	Year	Month	Day	Hour	Wind Direction (degrees)	Wind Speed (m/s)	Friction Velocity m/s	Threshold Velocity ^a m/s	Erosion Potential g/m ²
1	95	2	14	12	15.3	16.74	1.06	1.02	1.23
2	95	2	14	13	92.7	16.69	1.06	1.02	1.14
3	95	3	8	15	33.6	16.48	1.05	1.02	0.75
4	95	3	10	15	31.0	16.65	1.06	1.02	1.06
5	95	3	10	16	35.6	16.31	1.04	1.02	0.45
6	95	3	18	17	27.1	16.34	1.04	1.02	0.50
7	95	3	21	11	17.0	17.43	1.11	1.02	2.67
8	95	3	21	12	19.3	18.50	1.18	1.02	5.34
9	95	3	21	13	21.3	19.52	1.24	1.02	8.38
10	95	3	21	14	20.0	18.98	1.21	1.02	6.71
11	95	3	21	15	15.1	16.04	1.02	1.02	0.00
12	95	6	15	20	341.3	16.55	1.05	1.02	0.88
13	95	7	26	14	34.7	16.52	1.05	1.02	0.82
14	95	7	26	15	39.2	16.31	1.04	1.02	0.45
Total									30.38

a The friction velocity does not exceed the threshold velocity for roadbed material.

	Wind Erosion Emissions			
	Individual Site		Total Project	
	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)
TSP (30 um)	0.12	0.54	22.03	96.49
PM 10	0.06	0.27	11.01	48.25
PM 2.5	0.02	0.11	4.41	19.30

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5. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	15.0 miles (Estimated from project area and existing road system)
Hours of Construction	40 hours per site (5 days @ 8 hrs/day - Desolation Flats EIS Chapter 2)
Number of Heavy Diesel Truck Trips	5 (Estimated from Desolation Flats EIS Chapter 2)
Number of Pickup Trips	5 (Estimated from Desolation Flats EIS Chapter 2)
Diesel Fuel sulfur content	0.05 % (Typical value)
Diesel Fuel density	7.08 lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10 miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15 miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \# \text{Trips} * \text{Trip Distance (miles)}}{453.6 (\text{g/lb}) * 2000 (\text{lb/tons})}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO2 emissions are calculated on a mass balance basis utilizing the following equation:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 (\text{g/lb}) * \text{Fuel Sulfur Content} * 2 (\text{S / SO2})}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total ^d	
	E. Factor ^a (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor ^b (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.034	0.001	3.03	0.013	0.000	0.046	0.042
CO	17.09	0.071	0.001	33.64	0.139	0.003	0.210	0.189
VOC ^c	4.83	0.020	0.000	1.84	0.008	0.000	0.028	0.025
SO2	0.32	0.001	0.000	0.21	0.001	0.000	0.002	0.002

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)

b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 50,000 miles (6/95)

c Emission factor is for total Hydrocarbons.

d Assumes a maximum development rate of 45 wells/year

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6. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	15.0 miles (Estimated from project area and existing road system)
Hours of Operation	1320 hours per site (55 days @ 24 hrs/day - Desolation Flats EIS Chapter 2)
Number of Heavy Diesel Truck Trips	111 (Estimated from Desolation Flats EIS Chapter 2)
Number of Pickup Trips	307 (Estimated from Desolation Flats EIS Chapter 2)
Diesel Fuel sulfur content	0.05 % (Typical value)
Diesel Fuel density	7.08 lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10 miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15 miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \# \text{Trips} * \text{Trip Distance (miles)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO2 emissions are calculated on a mass balance basis utilizing the following equation:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2 \text{ (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total ^d	
	E. Factor ^a (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor ^b (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.023	0.015	3.03	0.023	0.015	0.046	1.364
CO	17.09	0.048	0.031	33.64	0.259	0.171	0.306	9.096
VOC ^c	4.83	0.013	0.009	1.84	0.014	0.009	0.028	0.819
SO2	0.32	0.001	0.001	0.21	0.002	0.001	0.003	0.075

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)

b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 50,000 miles (6/95)

c Emission factor is for total Hydrocarbons.

d Assumes a maximum development rate of 45 wells/year

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7. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	15.0 miles (Estimated from project area and existing road system)
Hours of Operation	160 hours per site (20 days @ 8 hrs/day - Desolation Flats EIS Chapter 2)
Number of Heavy Diesel Truck Trips	79 (Estimated from Desolation Flats EIS Chapter 2)
Number of Pickup Trips	104 (Estimated from Desolation Flats EIS Chapter 2)
Diesel Fuel sulfur content	0.05 % (Typical value)
Diesel Fuel density	7.08 lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10 miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15 miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \# \text{Trips} * \text{Trip Distance (miles)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO2 emissions are calculated on a mass balance basis utilizing the following equation:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2 \text{ (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total ^d	
	E. Factor ^a (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor ^b (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.133	0.011	3.03	0.065	0.005	0.198	0.712
CO	17.09	0.279	0.022	33.64	0.723	0.058	1.002	3.608
VOC ^c	4.83	0.079	0.006	1.84	0.040	0.003	0.118	0.426
SO2	0.32	0.005	0.000	0.21	0.005	0.000	0.010	0.035

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)

b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 50,000 miles (6/95)

c Emission factor is for total Hydrocarbons.

d Assumes a maximum development rate of 45 wells/year

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8. Development Tailpipe Emissions

Assumptions:

Average Round Trip Distance	15.0 miles (Estimated from project area and existing road system)
Hours of Operation	32 hours per site (4 days @ 8 hrs/day - Desolation Flats EIS Chapter 2)
Number of Heavy Diesel Truck Trips	11 (Estimated from Desolation Flats EIS Chapter 2)
Number of Pickup Trips	6 (Estimated from Desolation Flats EIS Chapter 2)
Diesel Fuel sulfur content	0.05 % (Typical value)
Diesel Fuel density	7.08 lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10 miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15 miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \# \text{Trips} * \text{Trip Distance (miles)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO2 emissions are calculated on a mass balance basis utilizing the following equation:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2 \text{ (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total ^d	
	E. Factor ^a (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor ^b (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.092	0.001	3.03	0.019	0.000	0.111	0.080
CO	17.09	0.194	0.003	33.64	0.209	0.003	0.403	0.290
VOC ^c	4.83	0.055	0.001	1.84	0.011	0.000	0.066	0.048
SO2	0.32	0.004	0.000	0.21	0.001	0.000	0.005	0.004

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)

b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 50,000 miles (6/95)

c Emission factor is for total Hydrocarbons.

d Assumes a maximum development rate of 45 wells/year

Buy's & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS Emission Inventory
 Date: 4/21/03

9. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	40 hours/site (5 days @ 8 hrs/day Desolation Flats EIS Chapter 2)
Development Rate	45 wells per year
Load Factor	0.4 (Assumed typical value)
Backhoe Size	100 hp (Assumed Typical value)
Dozer Size	150 hp (Assumed Typical value)
Motor Grader Size	135 hp (Assumed Typical value)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor ^a (g/hp-hr)	Emissions (lb/hr)	Emissions ^e (tons/yr)	E. Factor ^a (g/hp-hr)	Emissions (lb/hr)	Emissions ^e (tons/yr)	E. Factor ^b (g/hp-hr)	Emissions (lb/hr)	Emissions ^e (tons/yr)
NOx	8.15	0.719	0.647	8.15	1.078	0.970	7.14	0.850	0.765
CO	2.28	0.201	0.181	2.28	0.302	0.271	1.54	0.183	0.165
VOC ^c	0.37	0.033	0.029	0.37	0.049	0.044	0.36	0.043	0.039
PM10 ^d	0.5	0.044	0.040	0.5	0.066	0.060	0.63	0.075	0.068
PM2.5 ^d	0.5	0.044	0.040	0.5	0.066	0.060	0.63	0.075	0.068
SO2	0.22	0.019	0.017	0.22	0.029	0.026	0.22	0.026	0.024
Formaldehyde	0.22	0.019	0.017	0.22	0.029	0.026	0.12	0.014	0.013

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions ^e (tons/yr)
NOx	2.647	2.382
CO	0.686	0.617
VOC ^c	0.124	0.112
PM10 ^d	0.185	0.167
PM2.5 ^d	0.185	0.167
SO2	0.075	0.067
Formaldehyde	0.063	0.057

a AP-42 Volume II, Mobile Sources, Nonroad Vehicles, Table 11-7.1 Off-highway truck

b AP-42 Volume II, Mobile Sources, Nonroad Vehicles, Table 11-7.1 Motor Grader

c Emission Factor represents total Hydrocarbon Emissions

d All emitted particulate matter assumed to be PM2.5

e Assumes a maximum development rate of 45 wells/year

**Buys & Associates, Inc.
Environmental Consultants**

Project: Desolation Flats EIS Emission Inventory
Date: 4/21/03

10. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	1320 hours/well (55 days @ 24 hrs/day Desolation Flats EIS Chapter 2)
Development Rate	45 wells/year
Load Factor	0.4 (Assumed typical value)
Rig Size	2500 hp (Desolation Flats EIS Chapter 2)
Diesel Fuel Sulfur Content	0.05 % (typical value)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{2000 (\text{lb/tons})}$$

$$\text{SO2 E. Factor (lb/hp-hr)} = \text{Fuel sulfur content} * 0.00809$$

Species	Drill Rig Emissions		
	E. Factor ^a (lb/hp-hr)	Emissions (lb/hr)	Emissions ^e (tons/yr)
NOx	0.024	24.000	712.800
CO	0.0055	5.500	163.350
VOC ^b	0.000705	0.705	20.939
PM10 ^c	0.000573	0.573	17.018
PM2.5 ^d	0.000479	0.479	14.226
SO2	0.0004045	0.405	12.014

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96

b Emission Factor represents total Hydrocarbon Emissions

c Total particulate emission factor is 0.0007, PM10 fraction determined from Table 3.4-2

d Total particulate emission factor is 0.0007, PM2.5 fraction determined from Table 3.4-2

e Assumes a development rate of 45 wells/year

Buy's & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS
 Date: 4/21/03

11. Average Produced Gas Composition

COMPONENT	Gas Sample			Average Gas Composition* Mole %
	No. 4 Wedge Mole %	Lookout Wash # 1 Mole %	Cedar Chest # 31-5 Mole %	
Carbon Dioxide	3.469	3.278	3.310	3.352
Oxygen	0.000	0.086	0.260	0.115
Hydrogen Sulfide	0.000	0.000	0.000	0.000
Nitrogen	0.085	0.225	0.920	0.410
Methane	90.487	86.274	92.200	89.654
Ethane	3.567	6.887	2.590	4.348
Propane	0.827	2.047	0.380	1.085
Isobutane	0.318	0.290	0.100	0.236
n-Butane	0.139	0.502	0.060	0.234
Isopentane	0.145	0.125	0.030	0.100
n-Pentane	0.060	0.086	0.010	0.052
n-Hexane	0.054	0.002	0.010	0.054
Other Hexanes	0.140	0.123	0.001	0.038
Heptanes	0.313	0.075	0.069	0.122
C-8 + Heavies	0.396	0.000	DNR	0.140
Benzene	DNR	ND	0.019	0.019
Toluene	DNR	0.001	0.026	0.026
Ethylbenzene	DNR	ND	0.008	0.008
Xylenes	DNR	ND	0.008	0.008
TOTAL	100.000	100.000	100.000	100.000

* Note: HAP concentrations were conservatively estimated as the maximum observed value.

DNR = Did Not Report

ND = Not Detected

Buys & Associates, Inc.
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Project: Desolation Flats EIS Emission Inventory
Date: 4/21/03

12. Average Produced Gas Characteristics

Gas Heat Value (wet): 1037 Btu/scf

C1-C2 Wt. Fraction: 0.843
VOC Wt. Fraction: 0.069
Non-HC Wt. Fraction: 0.087
Total: 1.000

COMPONENT	MOLE PERCENT	COMPONENT MOLE WEIGHT (lb/lb-mole)	NET MOLE WEIGHT (lb/lb-mole)	WEIGHT FRACTION	GROSS HEATING VALUE (BTU/scf)	NET DRY HEATING VALUE (BTU/scf)	LOWER HEATING VALUE (BTU/scf)	NET LOW HEATING VALUE (BTU/scf)
Methane	89.654	16.043	14.383	0.773	1010.000	905.505	910.000	815.851
Ethane	4.348	30.070	1.307	0.070	1769.800	76.951	1618.000	70.351
Propane	1.085	44.097	0.478	0.026	2516.200	27.301	2316.000	25.129
i-Butane	0.236	58.123	0.137	0.007	3252.100	7.675	3005.000	7.092
n-Butane	0.234	58.123	0.136	0.007	3262.400	7.634	3013.000	7.050
i-Pentane	0.100	72.150	0.072	0.004	4000.900	4.001	3698.000	3.698
n-Pentane	0.052	72.150	0.038	0.002	4008.800	2.085	3708.000	1.928
Hexanes+	0.038	86.177	0.033	0.002	4756.200	1.807	4404.000	1.674
Heptanes	0.122	100.204	0.122	0.007	5502.500	6.713	5100.000	6.222
Octanes	0.149	114.231	0.170	0.009	6249.100	9.311		0.000
Nonanes	0.000	128.258	0.000	0.000	6996.400	0.000		0.000
Decanes	0.000	142.285	0.000	0.000	7743.200	0.000		0.000
Benzene	0.019	78.120	0.015	0.001	3715.500	0.706		0.000
Toluene	0.026	92.130	0.024	0.001	4444.600	1.156		0.000
Ethylbenzene	0.008	106.160	0.008	0.000	5191.500	0.415		0.000
Xylenes	0.008	106.160	0.008	0.000	5183.500	0.415		0.000
n-Hexane	0.054	86.177	0.047	0.003	4756.200	2.568		0.000
Helium	0.000	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	0.410	28.013	0.115	0.006	0.000	0.000	0.000	0.000
Carbon Dioxide	3.352	44.010	1.475	0.079	0.000	0.000	0.000	0.000
Oxygen	0.105	32.000	0.034	0.002	0.000	0.000	0.000	0.000
Hydrogen Sulfide	0.000	34.080	0.000	0.000	637.100	0.000	588.000	0.000
TOTAL	100.000		18.603	1.000		1054.243		938.995

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

Buys & Associates, Inc.
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Project: Desolation Flats EIS Emission Inventory
Date: 4/21/03

13. Completion Flare Emissions

Assumptions

Hours of Operation	3 days (Typical)
Amount of Gas Flared	2.5 MMscf/well (Reported by Project Proponents)
Average Gas Heat Content	1037 Btu/scf (Gas Analyses from Existing Wells)
Average Gas VOC Content	6.9 weight % (Gas Analyses from Existing Wells)
Average Mole Weight	18.6 lb/lb-mole (Gas analyses from Existing Wells)

Equations

$$\text{NOx/CO Emissions (lb/well)} = \text{Emission Factor (lb/MM Btu)} * \text{Gas Amount (MMscf/well)} * \text{Heat Content (Btu/scf)}$$

$$\text{PM/HAP Emissions (lb/well)} = \text{Emission Factor (lb/MMscf)} * \text{Gas Amount (MMscf/well)}$$

$$\text{Flare Gas Wt. (lb/well)} = \frac{\text{Flare Gas Volume (MMscf/well)} * 10^6 (\text{scf/MMscf}) * \text{Mole Weight (lb/lb-mole)}}{379.49 (\text{scf/mole})}$$

$$\text{VOC Emissions (lb/well)} = \text{Flare Gas Wt. (lb/well)} * \text{VOC wt. \%} * 0.02 \text{ (Assumes 98\% destruction Efficiency)}$$

	Emission Factor (lb/MMBtu)	Well Emissions (lb/well)	Well Emissions (lb/hr/well)	Total Emissions ^e (tons/yr)
NOx ^a	0.068	176.3	2.45	3.97
CO ^a	0.37	959.2	13.32	21.58
VOC	N.A.	169.1	2.35	3.80
SOx ^b	0.00	0.0	0.00	0.00

	Emission Factor (lb/MMscf)	Well Emissions (lb/well)	Well Emissions (lb/hr/well)	Total Emissions ^e (tons/yr)
TSP ^c	7.6	19	0.264	0.428
PM10 ^c	7.6	19	0.264	0.428
PM2.5 ^c	7.6	19	0.264	0.428
Benzene ^d	0.0021	0.00525	0.000	0.000
Toluene ^d	0.0034	0.0085	0.000	0.000
Hexane ^d	1.8	4.5	0.063	0.101
Formaldehyde ^d	0.075	0.1875	0.003	0.004

a AP-42 Table 13.5-1, Emission Factors for Flare Operations, 9/91

b Assumes produced gas contains no sulfur

c AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 3/98 (All Particulates are PM1.0)

d AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 3/98

e Assumes a maximum development rate of 45 wells per year

Buys & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS Emission Inventory
Date: 4/21/03

14. Production Heater Emissions

Assumptions

Separator Size	750 MBTU/hr (Reported by Project Proponents)
Dehydrator Size	250 MBTU/hr (Reported by Project Proponents)
Firing Rate	15 Minutes/hour for entire year (Typical value) 2190 hours/year
Fuel Gas Heat Content	1037 Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.069 by weight (Gas Analyses from Existing Wells)

Equations

$$\text{Fuel Consumption (MMscf/yr)} = \frac{\text{Heater Size (MBtu/hr)} * 1,000 (\text{Btu}/\text{MBtu}) * \text{Hours of Operation (hrs/yr)}}{\text{Fuel Heat Value (Btu/scf)} * 1,000,000 (\text{scf}/\text{MMscf})}$$

$$\text{NOx/CO/TOC Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{2,000 (\text{lbs/ton}) * 1,000 (\text{Btu/scf} - \text{Standard Fuel Heating Value})}$$

$$\text{VOC Emissions (tons/yr)} = \text{TOC Emissions (tons/yr)} * \text{VOC wt. fraction}$$

	Separator Emissions			Dehydrator Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Emissions (lb/hr/well)	Emissions ^e (tons/yr)	Emission Factor (lb/MMscf)	Emissions (lb/hr/well)	Emissions ^e (tons/yr)	Emissions (lb/hr/well)	Emissions ^e (tons/yr)
NOx ^a	100	0.019	31.618	94	0.006	9.907	0.025	41.525
CO ^a	21	0.004	6.640	40	0.003	4.216	0.006	10.856
TOC ^c	8	0.002	2.529	11	0.001	1.159	0.002	3.689
VOC	N.A.	0.000	0.175	N.A.	0.000	0.080	0.000	0.255
SOx ^b	0.00	0.000	0.000	0.00	0.000	0.000	0.000	0.000
TSP ^c	7.6	0.001	2.403	7.6	0.000	0.801	0.002	3.204
PM10 ^c	7.6	0.001	2.403	7.6	0.000	0.801	0.002	3.204
PM2.5 ^c	7.6	0.001	2.403	7.6	0.000	0.801	0.002	3.204
Benzene ^d	0.0021	0.000	0.001	0.0021	0.000	0.000	0.000	0.001
Toluene ^d	0.0034	0.000	0.001	0.0034	0.000	0.000	0.000	0.001
Hexane ^d	1.8	0.000	0.569	1.8	0.000	0.190	0.000	0.759
Formaldehyde ^d	0.075	0.000	0.024	0.075	0.000	0.008	0.000	0.032

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 2/98

b Assumes produced gas contains no sulfur

c AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 3/98 (All Particulates are PM1.0)

d AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 3/98

e Assumes a maximum development of 385 wells

Buy's & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS Emission Inventory
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15. Wellsite TEG Dehydrator Emissions

Assumptions

Production Rate: 1.0 MMscf/day per well as reported by the project proponents

Gas Composition: Samples from 3 existing wells were averaged. Maximum observed HAP concentrations were utilized for the analysis

Inlet Gas Conditions: Inlet gas was assumed to be saturated at 350 psi and 80 F as reported by the project proponents

Glycol Circulation Rate: 3 gallons/ lb of water (Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Emissions

Species	Emissions Per Well (tons/year)	Total Project Emissions ^a (tons/year)
VOC	11.32	4358
Benzene	0.87	335
Toluene	2.26	870
Ethylbenzene	1.23	474
Xylenes	1.60	616
n-Hexane	0.08	31
Total HAPs	6.04	2325

a Assumes a maximum development of 385 wells

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Desolation Flats
 File Name: A:\Desolation Flats GRI-Calc Run.ddf
 Date: April 21, 2003

DESCRIPTION:

Description: 1.0MMscf/day saturated wet inlet gas
 inlet conditions 350 psi and 80 F
 Kimray 4015 glycol pump
 3.0 gal/lb water glycol circulation ratio

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.3583	8.598	1.5692
Ethane	0.0588	1.412	0.2576
Propane	0.0362	0.868	0.1584
Isobutane	0.0151	0.363	0.0662
n-Butane	0.0197	0.472	0.0861
Isopentane	0.0121	0.290	0.0530
n-Pentane	0.0080	0.191	0.0349
n-Hexane	0.0184	0.441	0.0806
Other Hexanes	0.0096	0.230	0.0421
Heptanes	0.1018	2.444	0.4461
Benzene	0.1978	4.748	0.8665
Toluene	0.5156	12.375	2.2585
Ethylbenzene	0.2802	6.724	1.2271
Xylenes	0.3653	8.766	1.5999
C8+ Heavies	1.0056	24.135	4.4046
Total Emissions	3.0024	72.058	13.1505
Total Hydrocarbon Emissions	3.0024	72.058	13.1505
Total VOC Emissions	2.5853	62.048	11.3237
Total HAP Emissions	1.3773	33.054	6.0324
Total BTEX Emissions	1.3589	32.613	5.9519

EQUIPMENT REPORTS:

ABSORBER

Calculated Absorber Stages: 1.28
 Specified Dry Gas Dew Point: 5.00 lbs. H₂O/MMSCF
 Temperature: 80.0 deg. F
 Pressure: 350.0 psig

Dry Gas Flow Rate: 1.0000 MMSCF/day
 Glycol Losses with Dry Gas: 0.0019 lb/hr
 Wet Gas Water Content: Saturated
 Calculated Wet Gas Water Content: 73.51 lbs. H₂O/MMSCF
 Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H₂O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	6.79%	93.21%
Carbon Dioxide	99.90%	0.10%
Nitrogen	99.99%	0.01%
Methane	99.99%	0.01%
Ethane	99.98%	0.02%
Propane	99.95%	0.05%
Isobutane	99.92%	0.08%
n-Butane	99.88%	0.12%
Isopentane	99.86%	0.14%
n-Pentane	99.82%	0.18%
n-Hexane	99.66%	0.34%
Other Hexanes	99.75%	0.25%
Heptanes	99.26%	0.74%
Benzene	87.69%	12.31%
Toluene	80.27%	19.73%
Ethylbenzene	69.34%	30.66%
Xylenes	59.34%	40.66%
C8+ Heavies	96.18%	3.82%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.56%	70.44%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.45%	99.55%
n-Pentane	0.46%	99.54%
n-Hexane	0.48%	99.52%
Other Hexanes	0.94%	99.06%
Heptanes	0.49%	99.51%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.39%	89.61%
Xylenes	12.89%	87.11%
C8+ Heavies	11.96%	88.04%

STREAM REPORTS:

WET GAS STREAM

Temperature: 80.00 deg. F
 Pressure: 364.70 psia
 Flow Rate: 4.17e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.55e-001	3.07e+000
Carbon Dioxide	3.46e+000	1.68e+002
Nitrogen	4.09e-001	1.26e+001
Methane	8.95e+001	1.58e+003
Ethane	4.34e+000	1.44e+002
Propane	1.08e+000	5.25e+001
Isobutane	2.36e-001	1.51e+001
n-Butane	2.33e-001	1.49e+001
Isopentane	9.97e-002	7.91e+000
n-Pentane	5.21e-002	4.13e+000
n-Hexane	5.42e-002	5.14e+000
Other Hexanes	3.78e-002	3.58e+000
Heptanes	1.22e-001	1.35e+001
Benzene	1.87e-002	1.60e+000
Toluene	2.58e-002	2.61e+000
Ethylbenzene	7.82e-003	9.13e-001
Xylenes	7.69e-003	8.98e-001
C8+ Heavies	1.40e-001	2.62e+001
Total Components	100.00	2.06e+003

DRY GAS STREAM

Temperature: 80.00 deg. F
 Pressure: 364.70 psia
 Flow Rate: 4.17e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	2.08e-001
Carbon Dioxide	3.46e+000	1.67e+002
Nitrogen	4.10e-001	1.26e+001
Methane	8.97e+001	1.58e+003
Ethane	4.35e+000	1.44e+002
Propane	1.08e+000	5.25e+001
Isobutane	2.36e-001	1.50e+001
n-Butane	2.34e-001	1.49e+001
Isopentane	9.98e-002	7.90e+000
n-Pentane	5.21e-002	4.12e+000
n-Hexane	5.41e-002	5.12e+000
Other Hexanes	3.78e-002	3.58e+000
Heptanes	1.21e-001	1.34e+001
Benzene	1.64e-002	1.41e+000
Toluene	2.07e-002	2.10e+000

Ethylbenzene	5.43e-003	6.33e-001
Xylenes	4.57e-003	5.33e-001
C8+ Heavies	1.35e-001	2.52e+001
Total Components	100.00	2.05e+003

LEAN GLYCOL STREAM

Temperature: 80.00 deg. F
 Flow Rate: 1.42e-001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.82e+001	7.85e+001
Water	1.50e+000	1.20e+000
Carbon Dioxide	2.14e-011	1.71e-011
Nitrogen	1.06e-013	8.45e-014
Methane	4.38e-018	3.50e-018
Ethane	2.11e-008	1.69e-008
Propane	1.41e-009	1.13e-009
Isobutane	4.76e-010	3.81e-010
n-Butane	5.35e-010	4.28e-010
Isopentane	6.80e-005	5.43e-005
n-Pentane	4.59e-005	3.67e-005
n-Hexane	1.10e-004	8.83e-005
Other Hexanes	1.14e-004	9.12e-005
Heptanes	6.26e-004	5.01e-004
Benzene	1.30e-002	1.04e-002
Toluene	5.53e-002	4.42e-002
Ethylbenzene	4.06e-002	3.25e-002
Xylenes	6.76e-002	5.41e-002
C8+ Heavies	1.71e-001	1.37e-001
Total Components	100.00	8.00e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 80.00 deg. F
 Pressure: 364.70 psia
 Flow Rate: 1.55e-001 gpm
 NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.12e+001	7.85e+001
Water	4.72e+000	4.06e+000
Carbon Dioxide	2.31e-001	1.98e-001
Nitrogen	3.34e-003	2.88e-003
Methane	4.17e-001	3.58e-001
Ethane	6.84e-002	5.88e-002
Propane	4.21e-002	3.62e-002
Isobutane	1.76e-002	1.51e-002
n-Butane	2.29e-002	1.97e-002
Isopentane	1.41e-002	1.21e-002

n-Pentane	9.30e-003	8.00e-003
n-Hexane	2.15e-002	1.85e-002
Other Hexanes	1.13e-002	9.69e-003
Heptanes	1.19e-001	1.02e-001
Benzene	2.42e-001	2.08e-001
Toluene	6.51e-001	5.60e-001
Ethylbenzene	3.64e-001	3.13e-001
Xylenes	4.88e-001	4.19e-001
C8+ Heavies	1.33e+000	1.14e+000
Total Components	100.00	8.60e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
 Pressure: 14.70 psia
 Flow Rate: 8.00e+001 scfh

Component	Conc.	Loading (vol%)
		(lb/hr)
Water	7.53e+001	2.86e+000
Carbon Dioxide	2.14e+000	1.98e-001
Nitrogen	4.87e-002	2.88e-003
Methane	1.06e+001	3.58e-001
Ethane	9.28e-001	5.88e-002
Propane	3.89e-001	3.62e-002
Isobutane	1.23e-001	1.51e-002
n-Butane	1.60e-001	1.97e-002
Isopentane	7.95e-002	1.21e-002
n-Pentane	5.23e-002	7.96e-003
n-Hexane	1.01e-001	1.84e-002
Other Hexanes	5.28e-002	9.60e-003
Heptanes	4.82e-001	1.02e-001
Benzene	1.20e+000	1.98e-001
Toluene	2.65e+000	5.16e-001
Ethylbenzene	1.25e+000	2.80e-001
Xylenes	1.63e+000	3.65e-001
C8+ Heavies	2.80e+000	1.01e+000
Total Components	100.00	6.06e+000

Buys & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS Emission Inventory
Date: 4/21/03

16. Wellsite Condensate Storage Tank Flash Emissions

Assumptions:

Average Condensate Production Rate : 2 bbls per day (Average reported by proponents for existing wells)
0.083 bbls per hour

Separator Conditions : 380 psi and 80 F (Sampled Conditions)

Condensate Composition: Sampled and Analyzed from nearby well

Calculations:

Stock tank flash emissions estimated with HYSIM process simulation software

Emissions:

Component	Well Emissions (lb/bbl)	Well Emissions (tons/yr/well)	Project Emissions ^a (tons/yr)
Methane	5.049	1.84	709.5
Ethane	8.632	3.15	1213.0
Propane	21.5539	7.87	3028.9
I-Butane	11.7501	4.29	1651.2
n-Butane	15.8134	5.77	2222.2
I-Pentane	8.0714	2.95	1134.2
n-Pentane	6.0474	2.21	849.8
Hexanes	5.1862	1.89	728.8
Heptanes	1.9734	0.72	277.3
Octanes	0.3849	0.14	54.1
Nonanes	0.0685	0.03	9.6
Decanes	0.054	0.02	7.6
Benzene	0.1802	0.07	25.3
Toluene	0.2317	0.08	32.6
Ethylbenzene	0.0065	0.00	0.9
Xylenes	0.0624	0.02	8.8
Total VOC	71.384	26.06	10031.2
Total HAPS	0.4808	0.18	67.6

a Assumes a maximum development of 385 producing wells

Hyprotech's Process Simulator HYSIM - Licensed to
 Date 98/11/06 Version 386|C1.52 Case Name (ALGPU380)SIM
 Time 14:41:13 Prop Pkg PR

.Tank Emissions Calculat

Stream Description		STKVAP	STKLIQ
Vapour frac.		1.0000	0.0000
Temperature F		60.0000	60.0000
Pressure Psia		11.0000	11.0000
Molar Flow Lbmole/hr		1.8595	2.5014
Mass Flow Lb/hr		85.4452	240.9314
LiqVol Flow Barrel/day		11.4124	24.0000*
Enthalpy Btu/hr		12290.8497	-8213.9721
Density Lb/ft3		0.0919	43.3219
Mole Wt.		45.9513	96.3183
Spec. Heat Btu/lbmole-F		18.4543	47.4706
Therm Cond Btu/hr-ft-F		0.0103	0.0774
Viscosity Cp		0.0082	0.4460
Z Factor		0.9858	0.0044
Sur Tension Dyne/cm		---	19.7738
Std Density Lb/ft3		---	43.3237
Methane Lb/hr		5.0490	0.0282
Ethane Lb/hr		8.6320	0.3073
Propane Lb/hr		21.5539	3.0374
i-Butane Lb/hr		11.7501	4.5620
n-Butane Lb/hr		15.8134	8.9191
i-Pentane Lb/hr		8.0714	12.2702
n-Pentane Lb/hr		6.0474	12.6226
n-Hexane Lb/hr		5.1862	38.3598
n-Heptane Lb/hr		1.9734	49.3898
n-Octane Lb/hr		0.3849	32.3411
n-Nonane Lb/hr		0.0685	18.4045
n-Decane Lb/hr		0.0540	44.6162
Benzene Lb/hr		0.1802	1.3929
Toluene Lb/hr		0.2317	6.4383
o-Xylene Lb/hr		0.0624	7.6256
E-Benzene Lb/hr		0.0065	0.6110
H2O Lb/hr		0.0000	0.0000
CO2 Lb/hr		0.3233	0.0051
Nitrogen Lb/hr		0.0568	0.0001
Total: Lb/hr		85.4452	240.9314

C:\HYSIM\TANKSVOC\SEC21RUN\ALGPU380.SIM

Streams

New Value =				
Stream	HCLIQ01	HCLIQ02	HCLIQ03	EARTH
Vapour_Frac	0.0000	0.3150	0.4264	2.0000*
Temperature	80.0000*	29.0639	60.0000*	0.0000*
Pressure	380.0000*	12.0000*	11.0000	0.0000*
Flow	4.3609	4.3609	4.3609	0.0000*
Mass_Flow	326.3765	326.3765	326.3765	0.0000*
LiqVol_Flow	35.4124	35.4124	35.4124	0.0000*
Energy_Flow	-5478.0183	-5478.0183	4076.8779	-9554.8959
Stream	STKVAP	STKLIQ	---	---
Vapour_Frac	1.0000	0.0000	---	---
Temperature	60.0000	60.0000	---	---
Pressure	11.0000	11.0000	---	---
Flow	1.8595	2.5014	---	---
Mass_Flow	85.4452	240.9314	---	---
LiqVol_Flow	11.4124	24.0000*	---	---
Energy_Flow	12290.8497	-8213.9721	---	---

Attached to DUMPVALV

C:\HYSIM\TANKSVOC\SEC21RUN\ALGPU380.SIM

Streams

New Value =				
Stream	HCLIQ01	HCLIQ02	HCLIQ03	EARTH
Vapour_Frac	0.0000	0.3150	0.4264	2.0000*
Temperature	80.0000*	29.0639	60.0000*	0.0000*
Pressure	380.0000*	12.0000*	11.0000	0.0000*
Flow	4.3609	4.3609	4.3609	0.0000*
Mass_Flow	326.3765	326.3765	326.3765	0.0000*
LiqVol_Flow	35.4124	35.4124	35.4124	0.0000*
Energy_Flow	-5478.0183	-5478.0183	4076.8779	-9554.8959
Stream	STKVAP	STKLIQ	---	---
Vapour_Frac	1.0000	0.0000	---	---
Temperature	60.0000	60.0000	---	---
Pressure	11.0000	11.0000	---	---
Flow	1.8595	2.5014	---	---
Mass_Flow	85.4452	240.9314	---	---
LiqVol_Flow	11.4124	24.0000*	---	---
Energy_Flow	12290.8497	-8213.9721	---	---

Attached to DUMPVALV

Buys & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS Emission Inventory
 Date: 4/21/03

17. Wellsite Condensate Storage Tank Working and Breathing Emissions

Assumptions:

Average Condensate Production Rate :	2 bbls per day (Average reported by proponents for existing wells)
Tank Size :	400 bbls (Typical size)
Meteorological Conditions :	Average conditions for Cheyenne, WY utilized
Condensate Composition:	8.0 Reid Vapor Pressure (Assumed Typical Value)

Calculations:

Stock tank working and storage emissions estimated with EPA Tanks 4.0 software

Emissions:

Component	Well Emissions (lb/yr/well)	Well Emissions (tons/yr/well)	Project Emissions ^a (tons/yr)
Working Emissions	135.01	0.07	26.0
Breathing Emissions	1763.78	0.88	339.5
Total Emissions	1898.79	0.95	365.5

a Assumes a maximum development of 385 producing wells

TANKS 4.0

Emissions Report - Summary Format

Tank Identification and Physical Characteristics

Identification

User Identification: Desolation Flats
City: Baggs
State: Wyoming
Company: Desolation Flats EIS
Type of Tank: Vertical Fixed Roof Tank
Description: Typical 400 bbl condensate tank

Tank Dimensions

Shell Height (ft): 20.00
Diameter (ft): 12.00
Liquid Height (ft): 10.00
Avg. Liquid Height (ft): 5.00
Volume (gallons): 8,460,30
Turnovers: 3.70
Net Throughput (gal/yr): 31,303,10
Is Tank Heated (y/n): N

Paint Characteristics

Shell Color/Shade: Gray/Light
Shell Condition: Good
Roof Color/Shade: Gray/Light
Roof Condition: Good

Roof Characteristics

Type: Cone
Height (ft): 0.50
Slope (ft/ft) (Cone Roof): 0.08

Breather Vent Settings

Vacuum Settings (psig): -0.03
Pressure Settings (psig): 0.03

Meteorological Data used in Emissions Calculations: Cheyenne, Wyoming (Avg Atmospheric Pressure = 11.76 psia)

TANKS 4.0

Emissions Report - Summary Format

Liquid Contents of Storage Tank

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Vapor Max. Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Condensate (RVP8)	All	52.84	43.08	62.60	47.84	4.8304	4.0376	5.7402	50.0000

TANKS 4.0
Emissions Report - Summary Format
Individual Tank Emission Totals

Annual Emissions Report

Losses(lbs)			
Components	Working Loss	Breathing Loss	Total Emissions
Condensate (RVP8)	135.01	1,763.78	1,898.79

Buys & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS Emission Inventory
Date: 4/21/03

18. Gas Compression and Processing

Assumptions:

Gas Compression Power: 30,000 Horsepower (Based upon 385 MMscf/day, 350 psi to 1,000 psi)
Gas Plant Refrigeration Power: 2,000 Horsepower (Based upon propane refrigeration and avg. gas analysis)
Total Power Requirement: 32,000 Horsepower

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Pollutant	Emission Factor (g/hr-hr)	Emissions (lb/hr)	Emissions (tons/yr)
NOx ¹	1.0	70.55	309.0
CO ¹	3.0	211.64	927.0
VOC ¹	0.5	35.27	154.5
PM10 ²	0.022	1.55	6.8
PM2.5 ²	0.022	1.55	6.8
SO2 ³	0.0	0.00	0.0
Benzene ²	0.00180	0.13	0.6
Toluene ²	0.00064	0.05	0.2
Ethylbenzene ²	0.00003	0.00	0.0
Xylenes ²	0.00022	0.02	0.1
Formaldehyde ²	0.15	10.58	46.3

1 - Average Manufacturer Specified Emission Rate

2 - AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00

3 - Fuel gas is assumed to be free from sulfur compounds

Buys & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS Emission Inventory

Date: 4/21/03

19. Maximum Short-Term Construction Emission Summary

Pollutant	Short-Term Construction Emissions (lb/hr/well)					Wind Erosion	Max. Total (lb/hr/well)
	Construction	Drilling	Completion	Development	Maximum		
NO _x	2.69	24.05	2.65	0.11	24.05		24.05
CO	0.90	5.81	14.32	0.40	14.32		14.32
VOC	0.15	0.73	2.47	0.07	2.47		2.47
SO ₂	0.08	0.41	0.01	0.00	0.41		0.41
PM ₁₀	5.62	4.90	18.89	8.37	18.89	0.06	18.95
PM _{2.5}	1.28	1.11	2.99	1.22	2.99	0.02	3.01
Benzene							
Toluene							
Ethylbenzene							
Xylene							
n-Hexane			0.06		0.06		0.06
Formaldehyde	0.06		0.00		0.06		0.06

Buys & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS Emission Inventory
 Date: 4/21/03

20. Long-Term Construction Emissions Summary

Pollutant	Long-Term Construction Emissions (tons/year) ^a				Wind Erosion	Total (tons/yr)
	Construction	Drilling	Completion	Development		
NO _x	2.42	714.16	4.68	0.08		721.35
CO	0.81	172.45	25.19	0.29		198.73
VOC	0.14	21.76	4.23	0.05		26.17
SO ₂	0.07	12.09	0.04	0.00		12.20
PM ₁₀	5.06	145.47	67.47	6.03	12.20	236.21
PM _{2.5}	1.15	33.00	10.23	0.88	4.88	50.14
Benzene						
Toluene						
Ethylbenzene						
Xylene						
n-Hexane			0.10			0.10
Formaldehyde	0.06		0.00			0.06

a - Assumes a development rate of 45 wells per year

Buys & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS Emission Inventory
 Date: 4/21/03

21. Individual Well Production Emissions Summary

Pollutant	Individual Well Production Related Emissions (tons/year)					Wind Erosion	Total Production (tons/year)
	Separator Heater	Dehydrator Heater	Dehydrator Still Vent	Condensate Tank Flash	Tank Working and Storage		
NO _x	0.082	0.026					0.11
CO	0.017	0.011					0.03
VOC	0.000	0.000	11.32	26.06	0.95		38.33
SO ₂	0.000	0.000					0.00
PM ₁₀	0.006	0.002				0.27	0.28
PM _{2.5}	0.006	0.002				0.11	0.12
Benzene	0.000	0.000	0.87	0.07			0.94
Toluene	0.000	0.000	2.26	0.08			2.34
Ethylbenzene			1.23	0.00			1.23
Xylene			1.60	0.02			1.62
n-Hexane	0.001	0.000	0.08				0.08
Formaldehyde	0.000	0.000					0.00

Assumes an average well produces 1.0 MMscf/day of gas and 2.0 bbls/day of condensate

Buys & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS Emission Inventory
Date: 4/21/03

22. Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year)					Wind Erosion	Total Production (tons/year)
	Separator Heater	Dehydrator Heater	Dehydrator Still Vent	Condensate Tank Flash	Tank Working and Storage		
NO _x	31.618	9.907					41.53
CO	6.640	4.216					10.86
VOC	0.175	0.080	4358.20	10031.24	365.52		14755.21
SO ₂	0.000	0.000					0.00
PM ₁₀	2.403	0.801				48.25	51.45
PM _{2.5}	2.403	0.801				19.30	22.50
Benzene	0.001	0.000	334.95	25.32			360.27
Toluene	0.001	0.000	870.10	32.56			902.66
Ethylbenzene			473.55	0.91			474.46
Xylene			616.00	8.77			624.77
n-Hexane	0.569	0.190	30.80				31.56
Formaldehyde	0.024	0.008					0.03

Assumes 385 wells are producing 385 MMscf/day of gas and 770 bbls/day of condensate

Buys & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS Emission Inventory
 Date: 4/21/03

23. Total Project Emissions Summary

Pollutant	Project Emissions (tons/year)				Total Emissions (tons/year)
	Well Development	Well Production	Area Source Subtotal	Gas Compression and Processing	
NO _x	721.3	41.5	762.9	309.0	1,071.9
CO	198.7	10.9	209.6	927.0	1,136.6
VOC	26.2	14,755.2	14,781.4	154.5	14,935.9
SO ₂	12.2	0.0	12.2	0.0	12.2
PM ₁₀	236.2	51.4	287.7	6.8	294.5
PM _{2.5}	50.1	22.5	72.6	6.8	79.4
Benzene		360.3	360.3	0.6	360.8
Toluene		902.7	902.7	0.2	902.9
Ethylbenzene		474.5	474.5	0.0	474.5
Xylene		624.8	624.8	0.1	624.8
n-Hexane	0.1	31.6	31.7	0.0	31.7
Formaldehyde	0.1	0.0	0.1	46.3	46.4

Assumes 45 wells are developed each year and 385 wells produce
 385 MMscf/day of gas and 770 bbls/day of condensate on an annual basis

Buy's & Associates, Inc.
Environmental Consultants

Project: Desolation Flats EIS Emission Inventory
Date: 4/21/03

24. Reasonable Foreseeable Development (RFD) Emissions
Wells and Compression Associated with Approved NEPA Projects

Approved NEPA Action	Map Symbol	Project Area (km ²)	Remaining Wells to be Drilled	Compression to be Installed (hp)	Well NOx Factor (tons/yr/well)	NOx Emissions (tons/year)			NOx Emissions (tons/m ² /year)
						Wells	Comp.	Total	
Bird Canyon	BC	20.88	0	0	0.065	0.0	0.0	0.0	0
BTA Bravo	BB	23.80	2	0	0.065	0.1	0.0	0.1	5.46218E-09
Burley	BR	3.18	16	560	0.065	1.0	5.4	6.4	2.02749E-06
CAP Big Piney - Labarge	BP	501.65	200	0	0.065	13.0	0.0	13.0	2.59145E-08
Castle Creek Unit	CC	74.92	10	0	0.065	0.7	0.0	0.7	8.67592E-09
Continental Divide/Wamsutter II	CD	3,701.32	1768	58,100	0.08	141.4	561.0	702.5	1.89786E-07
Creston/Blue Gap	CB	1,272.00	156	5,460	0.065	10.1	52.7	62.9	4.942E-08
East LaBarge	EL	22.30	9	0	0.065	0.6	0.0	0.6	2.62332E-08
Essex Mountain	EM	50.67	3	0	0.065	0.2	0.0	0.2	3.84843E-09
Fontenelle Reservoir	FR	414.63	1017	0	0.065	66.1	0.0	66.1	1.59431E-07
Hay Reservoir	HR	73.33	0	0	0.065	0.0	0.0	0.0	0
Hickey-Table Mountain EA	HK	79.54	39	0	0.065	2.5	0.0	2.5	3.18708E-08
Jack Morrow Hills CAP EIS	JM	936.82	108	3,480	0.065	7.0	33.6	40.6	4.33628E-08
Jonah II EIS	J2	153.65	285	0	0.065	18.5	0.0	18.5	1.20566E-07
Miscellaneous Wells - East	WE	126.94	15	0	0.065	1.0	0.0	1.0	7.68079E-09
Miscellaneous Wells - West	WW	1,517.28	185	0	0.065	12.0	0.0	12.0	7.92537E-09
Moxa Arch	MA	972.68	1162	17,066	0.065	75.5	164.8	240.3	2.47071E-07
Pinedale Anticline EIS	PA	798.63	700	26,000	0.065	45.5	175.7	221.2	2.77025E-07
Riley Ridge	RR	541.40	209	0	0.065	13.6	0.0	13.6	2.50924E-08
Road Hollow Gas Plant EA	RH	150.89	0	0	0.065	0.0	0.0	0.0	0
Sierra Madre	SM	76.68	9	0	0.065	0.6	0.0	0.6	7.62911E-09
Soda Unit EA	SU	103.79	0	0	0.065	0.0	0.0	0.0	0
South Baggs	SB	214.08	43	2,580	0.065	2.8	24.9	27.7	1.29427E-07
Stagecoach Draw	SD	150.39	59	0	0.065	3.8	0.0	3.8	2.55004E-08
Vermillion Basin	VB	374.29	56	NOx Specified	0.065	3.6	200	203.6	5.4407E-07
Bridger-Teton DEIS includes Mngt. Areas:									
21 - Hoback Basin	HB	326.36	10	0	0.065	0.7	0	0.7	1.99167E-09
45 - Moccasin Basin	MB	234.63	5	0	0.065	0.3	0	0.3	1.38516E-09
71 - Union Pass	UP	354.30	5	0	0.065	0.3	0	0.3	9.17302E-10
72 - Upper Green River	GR	617.79	10	0	0.065	0.7	0	0.7	1.05214E-09
TOTAL		13,889	6,081	113,246		422	1,218	1,640	1.18079E-07

The well NOx emission factor for the various projects was assumed to be equivalent to the factor utilized in the Pinedale Anticline analysis, with the exception of the Continental Divide and South Baggs projects where the specific factor developed for those studies was utilized.

Compressor NOx emissions were estimated assuming an emission factor of 1 gram per horsepower hour, with the exception of Vermillion Basin where the maximum NOx emissions were specified at 200 tons per year.

For actions where compression was approved but no limits were addressed, the compression requirements were estimated at 35 horsepower per well.